
Space Weather Technical Forecast

Issued on Wednesday, 20 April 2022 at 13:34 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Slight chance X-flares (R3 Radio Blackouts), with further M-class flares (R1/R2 Radio Blackouts) likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity has been High with peak flare X2.2 observed at 20/0357 UTC from AR2992 which had rotated over the limb, and was perhaps partially occluded. This was also the source of a number of M-flares, include an M7 flare around 20/0134 UTC although this did occur alongside some brightening of AR2994 that was visible in SDO aia-94. A large complex region of sunspots is situated in the northeast disc, primarily comprising AR2993 Ehi/ beta-gamma and AR2994 Ehi/beta-gamma but also have a couple of smaller and simpler regions following, including AR2995 Hhx/alpha and two unnumbered regions. Elsewhere on the disc, there is one small sunspot AR2991 Axx/alpha on the central southern disc. No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, showed declining fast wind characteristics, likely from CH75/+. The solar wind speed has declined from around 450 km/s to near 400km/s. The density was average or below average. The magnitude of the Interplanetary Magnetic Field, Bt, was weak throughout, below 6nT, with its north-south component, Bz, varying between +/-4 nT. The phi angle was largely positive (away from the Sun) throughout. Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) was at Background levels throughout. The high energy electron flux (greater than 2MeV) reached High levels at the diurnal maximum, with 2220 pfu recorded at 19/1715 UTC, but declined to background to moderate after 20/0000UTC. The corresponding 24-hour integrated electron fluence was on a rising trend, close to the Active threshold but has recently peaked just below. This reached a value of 9.23e7 integrated pfu at 20/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Moderate over the next four days, with a chance of X-class flares (R3 Radio Blackouts), mainly from the large and fairly complex regions currently in the northeast quadrant. There is on ongoing likelihood of M-flares (R1/R2 Radio Blackouts)

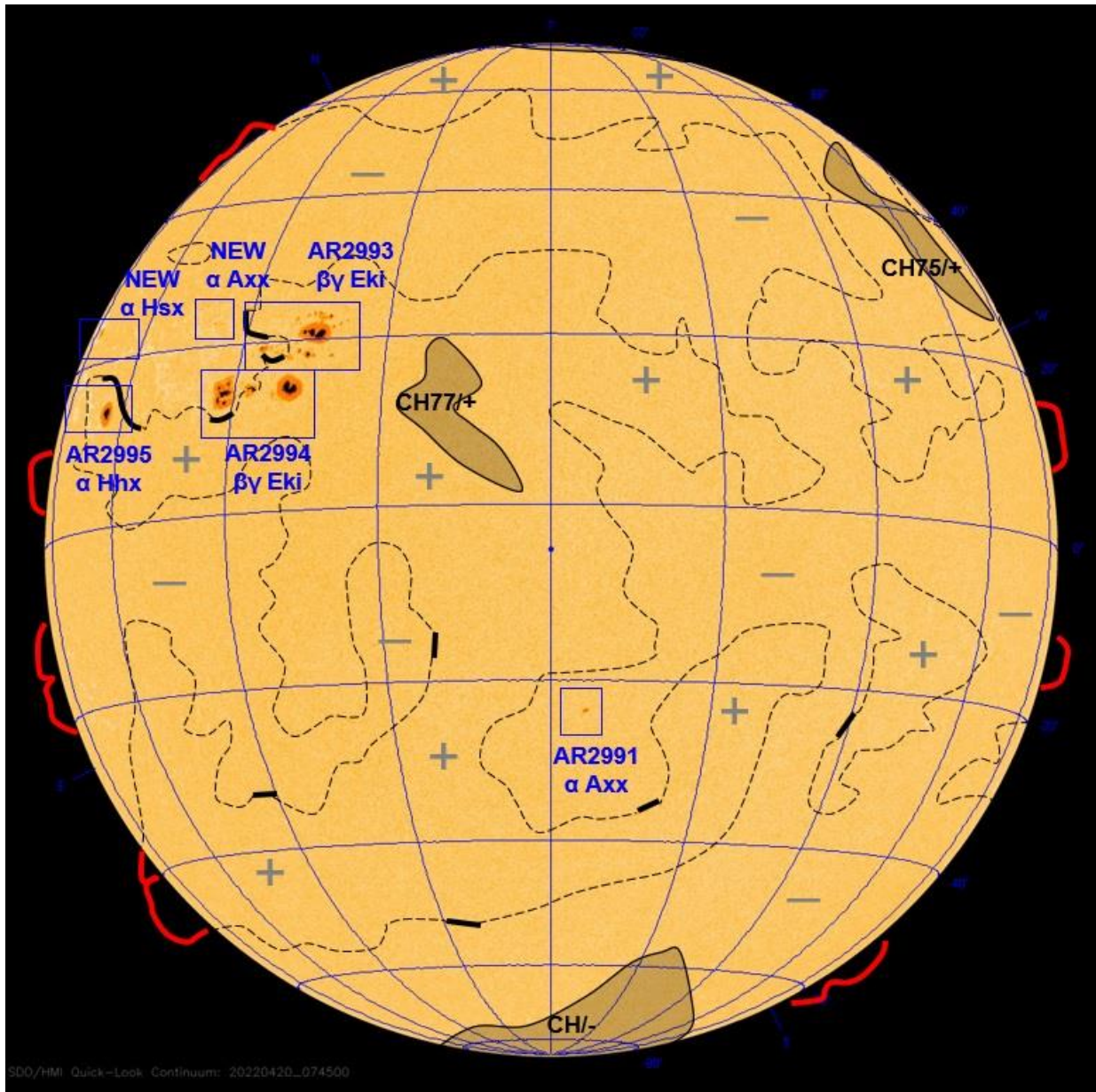
Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Solar winds at earth are expected to be mostly Background to slightly elevated, with a slight chance of enhancement later day 1 (20th) or day 2 (21st) from the arrival of the fast wind of CH76, This is low confidence however, as this feature is no longer visible on the solar disc. Geomagnetic activity is forecast to be mostly Quiet with isolated Unsettled intervals, but with a slight chance of a spell of Unsettled to Active given any fast wind arrival later day 1 or day 2.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels, although there is a very gradually increasing risk as the most complex regions rotate westward. The high energy electron flux has been generally Moderate to High levels although has fallen slightly below previous days values at time of issue. Any fast wind arrival could cause these values to drop out, however this is low confidence. The

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associated fluence is on a rising trend near the Active ($1e8$ integrated pfu) threshold, but is likely to stay below this level, with only a slight chance of rising above.

Figure 1. Solar Analysis Valid 20/0800 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are no Earth-directed CMEs.

Earth has seen recent fast wind enhancement from CH75 subside, with solar winds easing to be slightly elevated to background. There is a slight chance of a weak enhancement later day 1 or during day 2 (20th and 21st) from the arrival of the fast wind of CH76. This feature is no longer visible, but was evident when in the Earth-facing central disc, and also potentially the source of a weak enhancement at STEREO A late on the 18th, observing conditions around 2.5 days before Earth.

Geomagnetic activity is expected to be mainly Quiet with isolated Unsettled intervals throughout, however a spell of Unsettled to Active is possible given any fast wind arrival later day 1 or day 2 (20th-21st).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: STEREO A Solar wind speed for last three days



Radio Blackouts - X-Ray Flares:

Solar activity is currently High due to occurrence of a strong X2.2 flare from AR2992 from over the southwest limb. Looping is still visible on SDO aia-171 from this region, however this both much reduced and continues to rotate away from an observable location. Consequently any further significant flaring from this region is considered unlikely.

AR2993 Eki/Beta-gamma and AR2994 Eki Beta-gamma remain large and relatively complex regions in the northeast disc with a significant associated magnetic flux in their surrounding area. The latter of these regions was the source of a strong X1.1 flare on the 17th, although both of these regions have subsequently seen activity reduce to mostly C-flares. An M7 flare was observed at 20/0134UTC, and whilst likely to be primarily from AR2992 over the limb, some brightening was also observed in AR2994 in SDO aia-949 at the same time. Alongside this apparent reduction in activity, some of decay are evident in AR2994, with its trailer region breaking up. However some brightening and consolidation of visible looping in SDO aia-171 and aia-94 suggests there is still a potential for notable flaring. Further M-flares are likely from these spots, with a chance of X-flares.

There are four other regions on the Earth-facing disc, including three closer to the northeast limb. These are AR2995 Hx/alpha, which is currently a simple unipolar region, and a new Hsx/alpha region that has rotated on but is yet to be numbered. A newly developed Axx/Alpha has also emerged to the east of AR2993, which could be part of the same complex. A further small region AR2991 is situated in the southern central disc. These regions are notably smaller, and less likely to give significant flares at this stage.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	Yes	20	20	20	20

Figure 3: GOES-16/17 X-Ray Flux

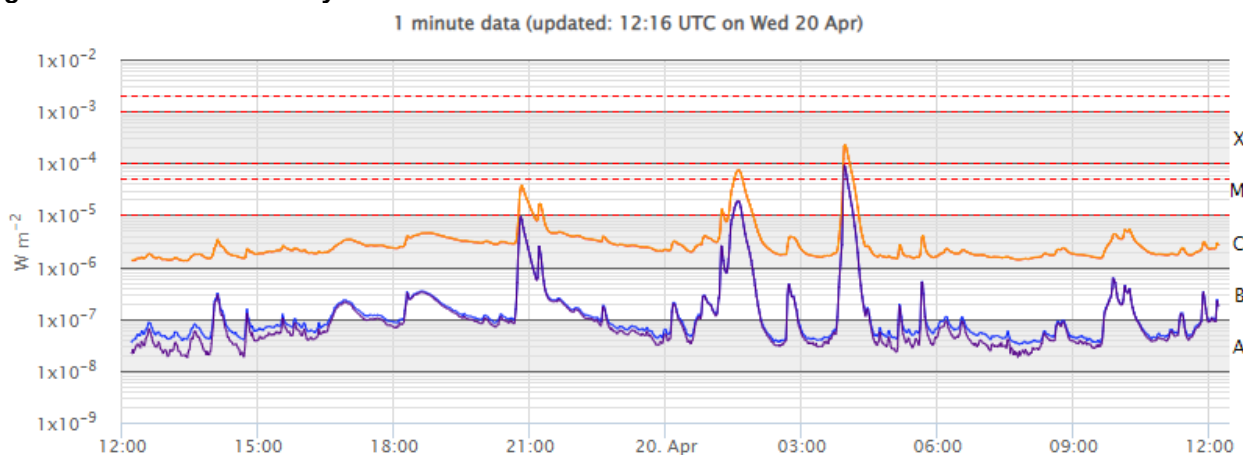


Figure 4: SDO euvi-imagery of X2.2 flare (left) and M7 flare (right). Notice both AR2992 and AR2994 appear bright in right hand image, although brightest flux from AR2992

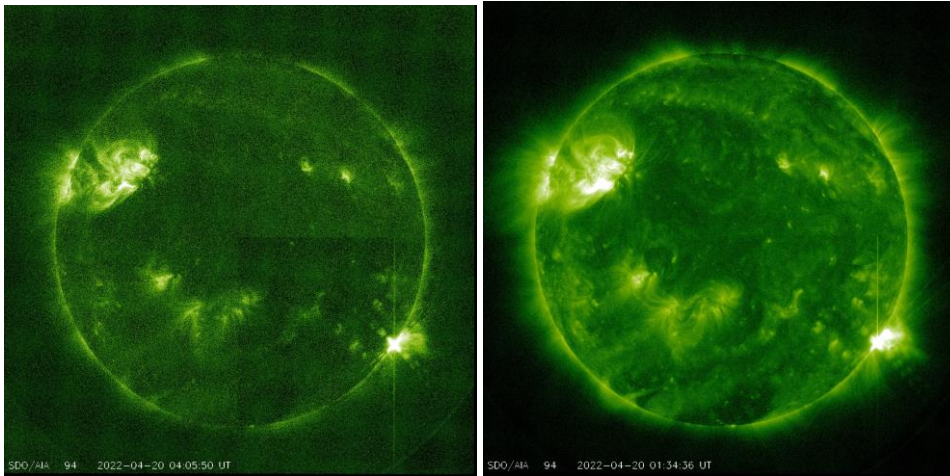


Figure 5: SDO Intensitygram (left) and Magnetogram (right) of NE of the sun, showing sunspots complex.

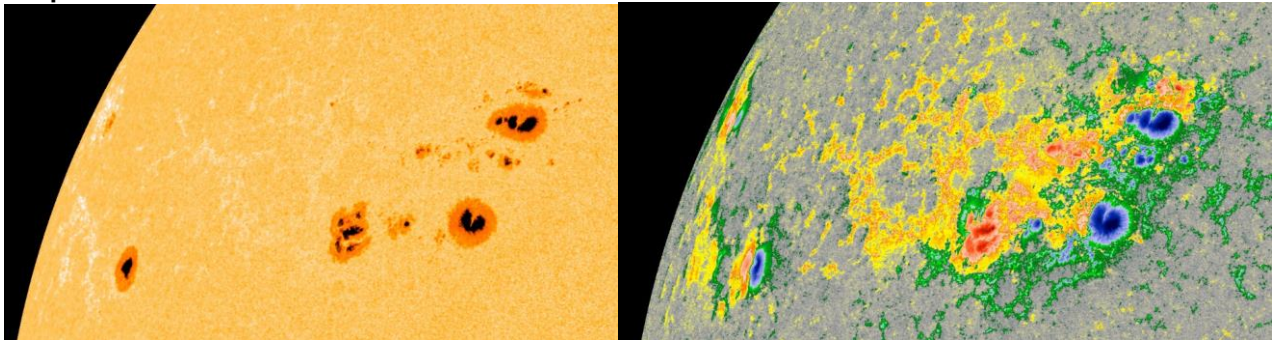
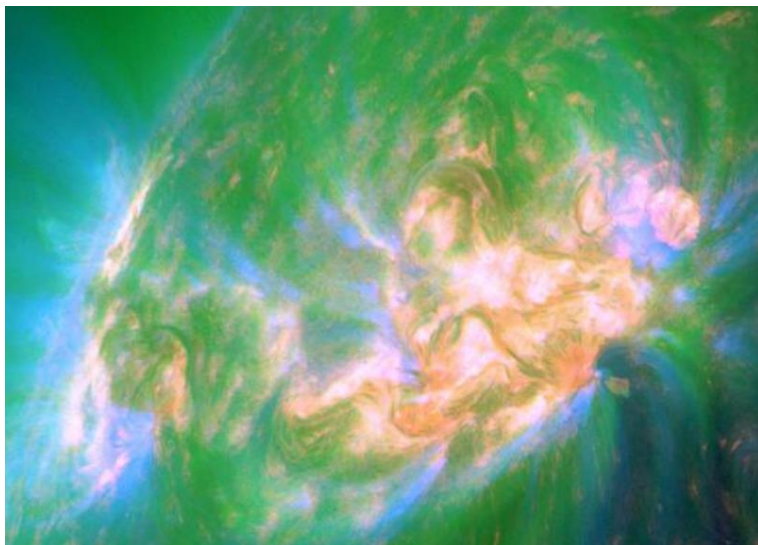


Figure 6: Difference imagery, showing complex looping still present in AR2993/AR2994 despite lack of recent activity



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at Background levels, and is most likely to remain so through the next four days. An X2.2 flare was observed from AR2992 just over the southwest limb, however proton flux remained at background. Observable flares from this region are becoming less likely, but do give a slightly increased chance of a proton response, mainly on day 1.

Otherwise AR2993 and AR2994 form a complex of sunspots across the northeast disc that is gradually rotating into a more geoeffective position for proton enhancement. Any notable flares from these regions have a slight, but increasing potential for proton storms to occur at Earth through the period.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	5	5	7	10
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2 \text{ MeV}$):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO has been varying between background and peak High levels. Whilst flux levels, at the time of writing are below observed values on the previous day, there is still the potential for peak values to rise day 1 (20th) as the solar wind environment around Earth relaxes. Any potential arrival of a further fast wind on day 1 or early day 2 could bring a drop out of flux returning to mainly background to Moderate levels. This arrival is low confidence however, with the potential for background to high levels to continue through the period, should this not materialise.

The associated Electron fluence has peaked at just below the Active threshold, but still has a slight chance of rising above on day 1 (20th), with a greater chance early day 2 (21st), before the influence of any fast wind arrival then occurs. If any drop out in flux is observed, then the chance of Active fluence throughout the rest of the period will decline. However, this arrival and potential dropout is low confidence, with REFM showing the potential for an increasing trend, should this not occur. Consequently a 30% chance of Active fluence is maintained.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	30	30	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 7: GOES-16 >2MeV Electron Flux (top) and associated fluence with REFM (bottom)

